Seabed Variability and its Influence on Acoustic Prediction Uncertainty

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LONG TERM GOALS

Assess and mitigate uncertainty in the tactical naval environment. The specific focus is on the important role of the seabed, which often is a controlling factor in the performance of sonar systems operating in shallow water. The specific goals are to:

1) Assess and characterize seafloor variability in shelf environments
2) Determine the impact of the seafloor variability on acoustic prediction uncertainty

OBJECTIVES

The objectives of this effort are to 1) characterize the spatial variability of the seabed geoacoustic properties using remote acoustic methods and 2) determine the uncertainties and errors associated with the estimation of the geoacoustic properties.

APPROACH

1. Process broadband seabed reflection data to extract the angular and frequency dependence of the reflection coefficient.
2. Analyze individual site reflection data (time series and reflection coefficients) to extract vertical geoacoustic variability of seabed surficial and sub-bottom properties.
3. Analyze site-to-site reflection data (time series, reflection coefficients, and geoacoustic data) to extract horizontal geoacoustic variability of the seabed.
4. Process scattering data to extract the angular and frequency dependence of the scattering strength. Analyze individual site scattering data using the geoacoustic data and attendant variability from step 3, to extract seabed stochastic parameters (e.g., sound speed and density fluctuation statistics and roughness statistics) describing fine-scale variability.
5. Analyze site-to-site scattering data (time series, scattering strength) to obtain mesoscale (0.1 – 10 km) horizontal variability in collaboration with Goff and Syvitski.
6. Compare deterministic and statistical geoacoustic characterizations between the acoustic inversion method with modeling characterization (Syvitski and Pratson) and direct measurement characterization (Goff). Bound errors/uncertainty in each of the 3 methods and seek new approaches based on a combination/merging of the relevant strengths.
7. Develop methods for characterizing seabed reflection variability so that realistic seafloor variability can be treated. As an example, shallow water random quasi-periodic layering

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14. ABSTRACT
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15. SUBJECT TERMS

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structures exist and may be fairly common, but are not represented in the current databases. These structures impose a distinct frequency dependence on the seabed reflection coefficient.

8. Develop methods for characterizing seabed scattering strength variability. In some cases scattering strength variability may be due to intrinsic variability in the sediment fabric itself, e.g., a localized gravel deposit. In other cases the variability of the scattering strength may be due only to geometric factors, e.g. layer thickness. At the core of this research is the identification and tracking of the scattering mechanism. By knowing the scattering mechanism, and tracking it laterally, one can determine whether the scattering strength variability is caused by geometric or intrinsic variability.

WORK COMPLETED

This project is in its very early phase. One reflection data set in the STRATFORM area and one on the Scotian shelf have been partially processed. The data were collected under the ONR GeoClutter Program and the joint ONR-NATO SACLANT Centre Boundary Characterization experiment in April- June 2001.

RESULTS

Figure 1 shows a sample of the high quality reflection data collected on the New Jersey shelf (STRATAFORM area). These data permit a very high resolution description of the vertical variability of the sediment properties. The properties of the second sediment layer (gravel) may be crucial for predicting sonar "clutter" events observed in the GeoClutter Experiment.

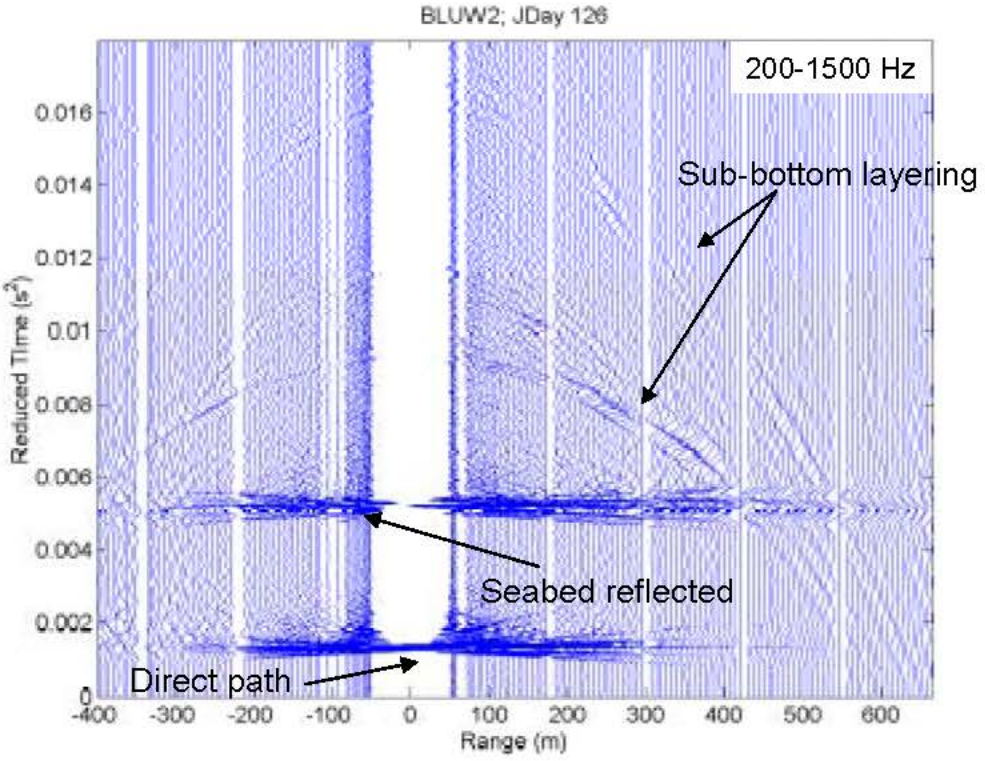

Figure 1. Filtered seafloor reflection data in the New Jersey STRATAFORM area. The data allow quantitative analysis of the sediment layering structure.

IMPACT/APPLICATIONS

New geoacoustic analysis techniques are being developed and applied to reflection and scattering data sets in order to probe the spatial variability and uncertainty associated with seabed properties. The results will be employed by propagation/reverberation modelers to determine the concomitant uncertainty in sonar performance.

RELATED PROJECTS

ONR GeoClutter: Providing high resolution geoacoustic data required for clutter modeling and aiding identification of clutter/scattering mechanisms.

Boundary Characterization Joint Research Project ONR-NATO SACLANT Centre: Collecting shallow water seabed reflection, monostatic and bi-static scattering data to support high fidelity physics-based modeling requirements and to support refinement of long-range environmental assessment techniques.